

Characteristics and design suggestions of industrialized residential buildings

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Abstract: The comparative study of industrialized buildings and traditional buildings is carried out. The characteristics of industrialized architecture are expounded from the aspects of engineering design, construction, and information control and so on. The design proposal of unified building modulus and optimization design method to adapt to the characteristics of industrialized building is put forward.

Keywords: industrialized building, building modulus, PC production.

1. INTRODUCTION

The industrialized building, which originated in 1930s, has developed in the past 80 years, and has become a common form of architecture abroad. The industrialized housing in China started late, and the former Soviet technology was introduced in the 60s of last century, but it has not been further developed because of the defects of the technical materials at that time. By the end of the twentieth Century, with the development of domestic economy, the domestic government and some enterprises began to pay attention to the feasibility of research on the development of new type of industrialized buildings in China [1]. Up to now, the industrialized housing in China has undergone a pilot stage of enterprise trial and social development, and has formed a new architectural form, which has become the trend of development and upgrading of traditional residential buildings and will soon usher in large-scale development. With the development of the new type of industrialized residential building, its design market will also usher in new content and challenges. With the development of the new type of industrialized residential building, its design market will also usher in new content and challenges.

2. DIFFERENCES BETWEEN INDUSTRIALIZED RESIDENTIAL BUILDINGS AND TRADITIONAL RESIDENTIAL BUILDINGS

The fundamental difference between the industrialized building and the traditional building is in the way of construction. The former is mainly composed of components and parts, cast-in-place (wet work) as a supplement. The latter is basically completed with a cast-in-place (wet) operation. For design purposes, the components and components of the industrialized

building are blueprints based on the design documents, and the construction is completed at the site after the factory is processed [2]. The design not only affects its function and beauty, but also has great influence on the cost. The main structure of the traditional residential building is completed by the integral cast in place. A few doors and windows, and canopy wet operation to complete the installation. The design has little effect on the cost of the construction and the production of the Ministry. Secondly, the construction error of industrialized buildings is less, the construction precision is high, and it is good for the implementation of the standardization of the internal assembly.

The construction of industrialization is in accordance with the industrialized production mode transformation process of construction industry, so as to gradually from handicraft production to large-scale socialized production. Its basic way is building standardization, assembly and accessories production industrialization, construction mechanization and scientific management of organization, and gradually adopts the new achievements of modern science and technology, so as to improve labor productivity, speed up construction, reduce engineering cost and improve engineering quality.

The promotion of industrialized building has promoted the upgrading of the structure of the construction industry [3]. The prefabricated construction mode of the building parts and components promotes the development of the upstream and downstream industry chain to a certain extent, improves the economic and social benefits, and makes the construction industry green and sustainable development.

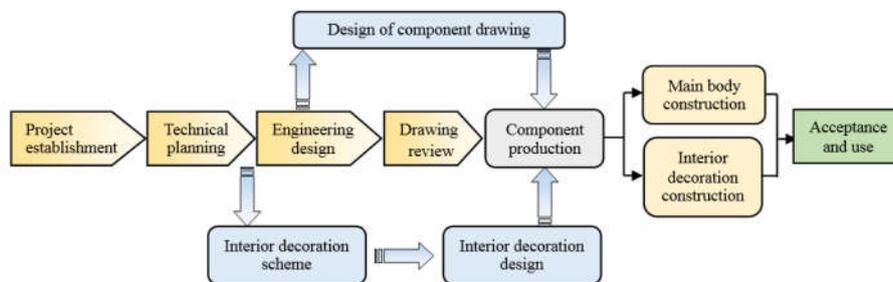


Figure 1. Industrialized construction project process

3. CHARACTERISTICS OF INDUSTRIALIZED RESIDENTIAL BUILDING DESIGN

3.1 Standardization of architectural design

Design drawings of the design standard of building will be built industrialized building are analyzed and deepened, according to certain standards of modulus and splitting to standardize components and products, the formation of the standardization series has a fixed feature of building products [4]. The standardization of architectural product design is helpful to reduce

the randomness of component design and split, simplify construction procedures and labor means, and make the building parts and components products better batch production.

The standardization of architectural design is the prerequisite for the factory production of the building parts and parts, and the basis of the industrialized production of the whole building parts. At the same time, the standardization of the building standard system and the standardization of the design of the ministry products make the production of the product develop from the general scale to the universal. It establishes the foundation of the modernization of the construction industry.

3.2 Factory production of components

The biggest change in the way the industrialized buildings are built is to transfer a large number of traditional cast-in-situ content into the factory. The production of most of the concrete and steel is carried out by the factory. Only hoisting and installation and little masonry work in the construction site.

In the process of plant production, component production preparation is separated from component manufacturing process, part of processes and semi-finished products are independently completed, and multiple production lines are pipelined, which greatly improves production efficiency and increases the production capacity of enterprises. Cutting from the reinforcing bar, remove the template group, embedded parts production, insulation material size, concrete pouring, concentrated to smooth, light pressure and maintenance, construction products fine and standardization of the advantage of filling, the standardized construction technology can not only improve workers' labor efficiency, but also effectively control the attrition rate of disposable materials and revolving materials, and improve the utilization of materials such as steel, concrete, wood, mortar and thermal insulation materials [5].

The overall precision of design, building components of the product production process, maintenance components can effectively improve the product quality, improve the construction parts precision and integrity, to ensure the construction unit components formed in the installation of the air tightness and water requirements, with energy saving, earthquake resistance, sound insulation effect. To enhance the function of building products.

3.3 Mechanization of construction

Site construction is mainly based on the installation of precast concrete components and fittings. Through mechanical lifting of precast concrete members, concrete members are joined by post pouring and grouting anchorage, and the concrete strength grade is achieved through maintenance. Because a large number of wet projects are transferred to factories, the construction site only carries out project such as node anchorage, node cast-in-place and so on, which greatly reduces the workload of field work, reduces the number of workers and reduces the labor cost [6]. At the same time, the mechanized construction operation improves the labor efficiency and speed of construction and shortens the project time limit.

In addition, the construction of assembly mechanization changed the shortcomings of traditional construction technology in the protection of ecological environment, effectively reduce the construction process, dust particles, harmful gas emissions, to achieve the effective control of environmental pollution, provides favorable conditions for the development of green prefabricated construction.

3.4 Scientific management organization

With the help of advanced electronic information technology, we can scientifically organize and manage project production and construction. From a systematic perspective, we should optimize the allocation of resources for design, construction and procurement of projects, increase the way of resource control, and improve the efficiency of resource utilization [6]. At the same time, the production mode and construction method of the fabricated building improve the skill requirements of the industrialized workers and promote the transformation of the existing "migrant workers" to "industrialized workers" to adapt to the complex skills operation process. The unified training and management will promote the management of industrialized workers and the specialization of technology to improve the quality of the whole production team. The unified organization and management, the construction of running water, and the more optimal allocation of resources provide an effective support for the development of the assembly architecture. The full cycle information management of industrialized buildings can be effectively realized by using BIM (Building Information Modeling) technology [7]. The unified organization and management, the construction of running water, and the more optimal allocation of resources provide an effective support for the development of the assembly architecture.

4. DESIGN PROPOSAL OF INDUSTRIALIZED RESIDENTIAL BUILDING

4.1 Unified modulus

The standard size unit of the building and its structure and fittings, and as the value-added unit in the dimension coordination, is called the building modulus unit. At present, in order to meet the needs of the design of individual facade and the space scale, the traditional project design process is becoming more and more unaware of the unified application of the architectural modulus. The industrialized residential building is based on the design of the unified modulus, so as to minimize the types of plant components and products and minimize the types of component production [8]. Therefore, the application of unified modulus should be considered at the beginning of the project design for industrialized residential buildings.

Take the house as an example, first of all to carry on the unification of the story height. The size standards of vertical components such as staircases, doors and windows can be unified. The size of the main bedroom, the secondary bedroom, the kitchen, the balcony, the bathroom and other functional rooms can be divided into the modules. When the unified modulus is determined, the interior design and the size of the installer must be fully considered.

4.2 Innovative design means

The diversified design of building facade materials and forms, and the outer dimension, multi-dimensional form and weight of components bring great difficulties to the production of precast PC components. Therefore, it is essential to choose a suitable design method to meet the requirements of the facade implementation.

At present, PC components factory production include PC, PCF, Vassar, exterior wall material components and other forms of GRC. In the design process, various factors such as the production cycle, cost, installation and transportation of the component can be considered, and the suitable form of the PC component can be selected flexibly [9].

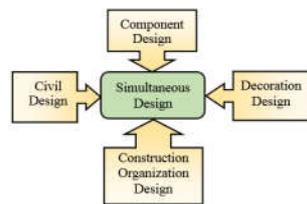


Figure 2. Content of Simultaneous Design

4.3 PC production of components

The symbol of the industrialized housing is the standardization of the residentialized building design, the production of the components, the mechanization of the construction and the scientific organization and management. In the process of industrialized housing construction, a lot of works are completed in factories, which can greatly reduce on-site wet operation, increase safety factor of construction and construction, and achieve the effect of energy saving and emission reduction. Therefore, when implementing industrialized housing, some owners began to pursue the maximum proportion of prefabrication. In fact, industrialized housing is the most industrialized mode of industrialized production. During the design process, the architect should consider the PC design of the area with the scale effect, the unified standard and the easy production. Secondly, the PC production of the parts with special requirements and quality requirements is made [10]. The PC is not used in the areas that are difficult to produce, have little influence on the site construction environment or cause complex construction. The greatest advantage is to play the role of prefabricated components.

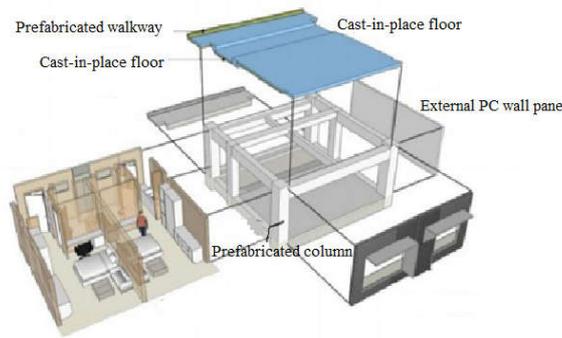


Figure 3. Sketch map of assembly construction of PC component

The design of connection structure node is the key point and difficulty in the design of industrialized housing. Not only has the requirement of performance, but also the simple and easy operation of the component production, construction and material replacement should be considered. Complex design of nodes will increase the cost of component production, and it will also increase the difficulty of construction. Safety performance in node design should be put in the first place, such as fireproof and waterproof, and fireproof adhesive is usually used to handle fire protection [11]. The treatment methods for waterproofing performance need to be considered comprehensively according to the climate characteristics. In rainy and typhoon regions, the waterproofing performance of nodes should be tested according to the most complex weather.

The separation and size of components should not only consider the needs of the design itself, but also take into account the technical and economic factors in the links of production, transportation and construction. In general, the length is no more than 6m, the height is not greater than 3.6m, the total weight is no more than 6T, lighter economy, bigger and heavier components can be considered in cast-in-place production or in low multi-story buildings. The main cost of a large number of industrialized buildings is die allocation and transportation cost. In the design, we need to timely evaluate and compare the effects of various plans on mold reuse rate and transport efficiency, control unnecessary pursuit and bring cost and waste to improve product cost performance.

4.4 Standardization and modularization

The advantage of industrialized building lies in the promotion of cost performance under scale application. The premise of scale benefit is the wide application of standardization and modularization. The standardized design includes the standardization of components, the standardization of the department, the standardization of the unit, the standardization of the building, and so on [12]. The advantage of modularization is that standardization can be made to diversify any unit so as to realize the differentiation from detail to level, facade, planning and other aspects to meet people's needs for individual products.

4.5 Design cycle and professional cooperation

The design period of the industrialized building is longer than that of the traditional project because of its more professional coordination, wide design, comprehensive consideration and high requirement. Table 1 compares the cycle requirements of industrialized buildings and traditional projects.

Table 1. comparison of the cycle requirements of industrialized buildings and traditional projects

design phase	Traditional project cycle (day)	Industrialized project cycle (day)	Compared with the traditional cycle
scheme design phase	30	45	increase 15 days
preliminary design phase	45	55	increase 10 days
construction drawing	55	65	increase 10 days
component drawing	/	20	increase 20 days
total	130	185	increase 55 days

Table 2. the time requirements for every participant in the industrialized building

Key design conditions	Time node	Related units
Component plane resolution	Before the end of scheme phase	construction unit
Preliminary plan for facade design	Before the end of scheme phase	construction unit
External facade decoration material scheme	Within 30 days of preliminary phase	construction unit
Interior decoration plan	Within 30 days of preliminary phase	interior design unit
Energy saving design scheme	Within 30 days of preliminary phase	Energy saving design unit
Green building condition design	Within 30 days of preliminary phase	Green building consulting unit
Construction organization design	Within 30 days of preliminary phase	Construction unit
Installation and pre-embedding scheme	Within 30 days of construction drawing	Installation unit
Design of construction temporary facilities	Within 30 days of construction drawing	Construction unit
Hoisting reburials	Within 30 days of construction drawing	Component manufacturer and Construction unit
Detailed design of doors and windows	Within 30 days of construction drawing	Door and window factory

In the design of industrialized buildings, partners and time nodes have great influence on each stage of the design work. Table 2 shows the time requirements for every participant in the industrialized building.

5. SUMMERY

With the increasingly encouraging policy of the state, the gradual improvement of the regulations and norms of the industrialized residential buildings, and the pilot and demonstration of the large area of the government housing and commercial housing, the development of the industrialized residence will enter a new stage.

As an important part of the industrialized chain, design still needs to be summarized and improved in practice, so as to promote faster and better development of industrialized housing.

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